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would not really exist; on the contrary, the structural elements in the crystallized salt would be of two sorts—namely, R and $3H_2O$."[1]

Hence it is geometrically possible that the structural elements of a crystal may be different atomic groups which are held in a position of stable equilibrium by virtue of being interpenetrating networks.

A GENERAL PRELIMINARY DESCRIPTION OF THE DEVONIAN ROCKS OF IOWA; WHICH CONSTITUTE A TYPICAL SECTION OF THE DEVONIAN FORMATION OF THE INTERIOR CONTINENTAL AREA OF NORTH AMERICA.

BY CLEMENT L. WEBSTER.

The area of the Devonian rocks in North America presents at least four distinct types of stratigraphy in their sections, in different parts of the continent.

The four types blend, more or less, at their borders, but in their central area are quite distinct.

The four areas may be called,—

(1) "*The Eastern Border Area,*" including the outcrops of Gaspé, New Brunswick, Maine, and other places in Northern New England.

(2) "*The Eastern Continental Area,*" including the New York and Appalachian tracts as far South as West Virginia, and extending Northwestward into Canada West and Michigan.

(3) "*The Interior Continental Area,*" typically seen in Iowa, and extending into Missouri, Illinois, Indiana, and probably Northward toward the valley of the Mackenzie River, and—

(4) "*The Western Continental Area,*" best known through Hague and Walcott's studies of the Eureka, Nevada, sections.[2]

Each of these four types presents sections of the Devonian, which in most of the details of stratigraphical, lithological and palaeontological composition, differs greatly from the others; although all at the same time, by various links of evidence, demonstrate that they represent the same geological age, and usually show, more or less distinctly, a similar order of sequence.

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[1] Sohncke, *Zeitsch. f. Kryst.* xiv. p. 443.

[2] This classification of (in part) Professor H. S. Williams (American Geologist, Special Number, October, 1888, p. 228) we here adopt, provisionally.

In this report it is our aim to deal, more particularly, with the typical section (Iowa) of the Interior Continental Area.

The area of surface occupied by the rocks of Devonian age in Iowa comprises a wide strip of country, the general trend of which is Northwestward and Southeastward.

It is about two hundred miles in length and fifty miles in width; the general details of its outlines may be seen upon the geological map of the State; which, however, demands some important modifications.

The rocks of this age, in Iowa, have been referred by geologists to different epochs; for instance, the shales and sandstone, which occupy the upper portion of the Devonian stratum near the mouth of Pine Creek, and at other points on the Mississippi, to the Chemung group; and the limestone and shales, occupying a "lower"? horizon, at Davenport, Iowa City, Independence, &c., and the shales at Rockford and Hackberry, to the Hamilton Group (Hall's Geology of Iowa, VOL. I. PART 1 and 2, 1850).

The rocks also at Cedar Falls, have been réferred by Professor A. H. Worthen, to the Chemung group (*Loc. cit.*)

Some years later, in 1873, a reëxamination of some of the rocks of this age was made by Hall and Whitfield, and the limestone at Waterloo, and the shales at Rockford, were declared to be the equivalents of the New York Corniferous and Chemung Groups, respectively (23d Report on State Cabinet of New York, pp.,223-226) Again, Prof. H. S. Williams, in 1883 (American Journal of Science, February, 1883), referred the shales at the top of the Devonian, at Rockford and Hackberry, to the base of the Chemung of the New York Geologists, and, more recently, to the upper part of the Hamilton of the New York Section (American Geologist, Special Number, 1888, pp, 240, 242, &c.).

On the other hand, Dr. C. A. White (Geology of Iowa, 1870, VOL. I., p. 178) is of opinion that *all* the Devonian strata of Iowa, belong to a single epoch, the Hamilton.

By various other writers, the rocks of this age have been referred to each of the several divisions of the New York section.

The thickness of the Devonian rocks of Iowa, have been variously estimated by different writers on the subject, at from 150 feet to 200 feet.[1] This formation is quite conformable both with the Niagara rocks below, and the Carboniferous rocks above, throughout nearly, or quite their entire extent in the State. These rocks, as they occur in this State, are separable into *three* general, more or less well marked lithological and palaeontological divisions, and whose order of sequence can be made out.

The lowest division of this section, which, in its general lithological character, as observed in its Eastern extension at different points along the Mississippi, at, and adjacent to Davenport, is a rather hard, gray, brown, and buff limestone; at times somewhat arenaceous and argillaceous, with slight intercalated beds of shale, and gray and brown brecciated limestone, sometimes attaining a thickness of eight feet. A portion at least, of the rocks of this division, are here separated from the underlying Niagara limestone by a fault, the space being filled by coal measure deposits.[2]

This formation carries, at different horizons, a rich and varied fauna; while at other horizons, the strata are devoid of organic remains.

These rocks contain a fauna which represents both the Corniferous, Hamilton, and Chemung faunas, as well as a few forms characteristic of the Trenton and Niagara rocks below. Of the very large numbers of species of fossils (more than two hundred) collected from these rocks, over three-fourths are found to be characteristic of the Corniferous epoch. Of those forms representing the fauna of other epochs, their ratio of occurrence is, as in the following order: Hamilton, Niagara, Chemung and Trenton.

Or in other words, the larger number are peculiar to the Hamilton group, the second largest number are peculiar to the Niagara group, the third Chemung, and the fourth Trenton.

The following enumeration is that of some of the species characteristic of this division:

Arcophyllum oneidense
Callonema bellatulum
Callonema lateradum
Cladopora fisheri
Cystiphyllum impositum
Cystiphyllum vadum

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[1] Hall's Geology of Iowa, VOL. I., PART I, 1858; C. A. White, Geology of Iowa, 1870; J. D. Dana, Manual of Geology, p 267; H. S. Williams, American Geologist, Special Number, October, 1888, p 233.

[2] A. S. Tiffany, Geology of Scott County, Iowa, and Rock Island County, Illinois, &c., p. 13.

Diphyphyllum simcoense
Orhoceras faculum
Strophodonta nacrea
Syringopora perelegans
Syringostroma densum
Zaphrentis nitida
Acrophyllum oneidaense
Alveolites subramosus
Atrypa hystrix
Aulacophyllum convergens
Aulacophyllum princeps
Blothrophyllum promissum
Centronella hecate
Chonophyllum vandum
Cladopora pinguis
Cladopora robusta
Clisiophyllum ohioense
Callonema imitator
Cyathophyllum clintonensis
Cyathophyllum cornicula
Cyathophyllum impositum
Cystiphyllum ohioense
Favosites canadensis
Favosites limitaris
Orthis iowensis
Platyceras carinatum
Pleurotomaria hebe
Phillipsastrea gigas
Spirifera fimbriata
Spirifera gregaria
Spirifera varicosa
Strophodonta hemispherica
Terebratula elia
Zaphrentis compressa
Zaphrentis exigua
Zaphrentis prolifica
Zaphrentis wortheni[1]
Leperdita cayuga
Productella subaculeata
Syringopora nobilis
Syringostroma columnare
Zaphrentis exigua
Zaphrentis subconstricta
Alveolites squamosus
Atrypa aspera
Atrypa reticularis
Aulacoplyllum reflexum
Bellerophon pelops
Centronella glansfagea
Chonetes lineata
Cladopora labiosa
Cladopora pulchra
Clisiophyllum convergens
Crania bordeni
Cyathophyllum arctifossum
Cyathophyllum coalitum
Cyathophyllum conigerum
Cyathophyllum houghtonii
Cyathophyllum davidsonii
Favosites basalticus
Favosites emmonsii
Naticopsis humilis
Paracyclas lirata
Pleurotomaria aplata
Pleurotomaria rotalia
Proetus canaliculatus
Spirifera mucronata
Spirifera euruteines
Strophodonta concava
Strophodonta patersonii
Zaphrentis cruciforme
Zaphrentis conigera
Zaphrentis gigantea
Zaphrentis ungula

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[1] For a portion of this list of species we are indebted to Mr. A. S. Tiffany, of Davenport, Iowa,

No well-marked lithological or biological sub-division of these rocks has been observed.[1]

In the eastern extension of the Corniferous rocks, in Iowa, they are seen to be succeeded upward by gray, brown and buff, calcareous and argillaceous shales, limestone, and coarse and fine-grained sandstones of the Hamilton group.

While at some localities the two divisions are sharply defined, both lithologically and biologically, still at other points these characters of the two formations so gradually blend as to make it a matter of great difficulty, if not an impossibility, to designate just where the line of separation between the two groups should be drawn.

As might be naturally expected, throughout the area occupied by these divisions, the mingling of their faunas is much more strongly marked at their junction with each other.

In their interior area, the line of division between the two groups is nowhere distinctly shown, either by lithological or biological evidence. According to the record of the boring of the artesian well at Davenport, kindly furnished me by Mr. A. S. Tiffany, and which may be considered as approximate, the thickness of the Corniferous rocks, in that vicinity, is shown to be one hundred and eighty feet.

At one locality, Independence, the Corniferous limestones are succeeded upward by a blue shale, which here forms the base of the Hamilton, and which, from its order of sequence, we would consider to be the equivalent of the " Marcellus Shales" of eastern sections, although differing in some respects, in its lithological and biological characters, from them.

The beds of this serial are somewhat variable, lithologically, consisting of thin bands of concretionary limestone, and dark blue, argillaceous, fine-grained shales, which are highly charged with bituminous matter, and interlaminated by seams of coal, from one-eighth to one-fourth of an inch in thickness. This shale weathers, on exposure, to a light blue clay, and contains an abundance of fossil shells, a few species of corals and cerinoid remains ; while some of the beds hold numerous remains of land plants (*Lepidodendron* and *Sigillaria*).

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[1] This Division has been referred, by Rev. Dr. Barris, to the Upper Helderberg, and its thickness estimated at nearly one hundred feet, ("Local Geology of Davenport and Vicinity.") Proceedings of Davenport Academy of Science, VOL. II, 1880. This formation has also been referred to the Corniferous, by Mr. A. S Tiffany, (Geology of Scott County, Iowa, and Rock Island County, Illinois, etc., 1885.)

This division represents an old shore deposit, and carries, in its fauna and flora, evidence both of its terrestial and marine origin; and marks, as well, the dawn and culmination of terrestial vegetation of the old Devonian time, in Iowa.

The thickness of this division is probably thirty feet or more, although only about twenty-five feet have actually been observed.

These shales, which represent only a *local* sub-division of the Hamilton, were first recognized by Mr. D. S. Deering, of Independence; and subsequently described by Prof. S. Calvin, as "Some Dark Shales Below the Devonian Limestone at Independence, Iowa" (Bulletin of U. S. Geological Survey, VOL. IV., No. 3, 1878.)

In this publication, the statement was made (p. 726) "That the shale in question is not a mere local deposit, but is distributed all along the outcrop of the Devonian Rocks of Iowa."

An extended study of all the Devonian rocks of this State, and the record of numerous borings along its Eastern outcrop, and at other points, has failed to adduce any evidence of the existence of this formation at other localities.

One of the highest members of the Hamilton, in its Eastern extension, is a soft, friable, brownish-yellow sandstone, which is well shown as it out-crops on Pine Creek, some distance above "Pine Creek Mill." This stratum of sandstone here forms a bold escarpment or cliff, about forty feet in height, is obliquely and discordantly stratified throughout, dips rapidly in a southerly direction, and is, so far as observed, devoid of fossils.

At Independence, the blue shales (equal Marcellus Shales) are succeeded upward by heavy bedded, sometimes indistinctly stratified dove-colored and buff limestone, and intrusive beds of shale, with a thickness of twenty-one feet. The lower portion of the limestone here is indistinctly stratified, but is often crossed diagonally and irregularly by seams which cause it to split into uneven slabs and fragments.

As we recede to the West and Northwest from the attenuated Eastern outcrop of the Hamilton, the rocks overlying the blue shales are seen to rapidly increase in thickness, until, on the Wapsipinecan River, only one and one-half miles from the exposure of blue shales they are seen to attain an estimated thickness of sixty-five feet; while on the same stream at Littleton, ten miles to the Northwest, the same rocks are observed to attain a slightly greater thickness.

The following is a partial list of the species occurring at this horizon :

The rocks of the lower portion of the Hamilton are generally heavier bedded, more compact, and uniform in texture, and usually a more pure limestone than those of the upper portion The prevailing color of the strata of this horizon, is blue, and bluish-gray.

In the northern portion of Johnson County, (for instance, at the "State Quarry," Robert's Ferry, Solon, etc.,) occurs a bed of peculiar grayish-white limestone, nothing like it being known to exist in other portions of the State.

This bed has a thickness of from six inches to six feet, or more, is very crystalline throughout, and is made up, to a considerable extent, of broken shells of different species of Brachiopoda, some of which are not known to occur elsewhere in Iowa.

For convenience in subsequent allusion, this bed is here designated the *Shell Bed.*

Underlying this shell bed is a stratum of very hard, fine-grained, blue brecciated limestone.

This limestone is observed at various localities in this portion of the State, and is known to extend as far North as Raymond Station, in Black Hawk County.

The upper portion of this division is made up, for the most part, of thin bedded magnesian and common limestone, and soft, impure, calcareous, argillaceous and silicious, shales and sandstones, of a prevailing grayish-buff color.

In the Eastern portion of Floyd County, some beds of shale, occupying a considerable area, are extensively sun-cracked ; this indicating an elevation of the sea-bottom here, and the exposing of it for some time to etheral conditions and the burning rays of the sun.

The extreme upper portion of this division is almost everywhere, a hard, fine-grained, and brittle, grayish or dove-colored limestone, and singularly devoid of organic remains.

Immediately succeeding the limestone, in portions of Floyd, Cerro Gordo and Worth Counties, and constituting the highest member of the Hamilton group in the State, is a stratum of stiff blue clay, varying from twenty to twenty-five feet in thickness.

This formation, which is entirely devoid of organic remains, may be best seen as it outcrops on Lime Creek and Willow Creek, in Floyd and Cerro Gordo Counties, particularly at Rockford, Hackberry, and a locality three miles west from Mason City, on Willow Creek.

This serial, judging from its lithological character and order of sequence, appears to be the equivalent of the "*Genesee Shales*" of the New York section, and to which division we would here refer it.

As we have before intimated, the base of the Hamilton, represented by the blue Shales at Independence, carries a rich Fauna, and evidence, also, of the former existence of a rich, and perhaps varied, flora, which was restricted to this zone.

Of the fossil species occurring in this serial, the following may be enumerated:

Strophodonta arcuata
Strophodonta calvini
Strophodonta reversa
Atrypa reticularis
Spirifera subumbonata
Gypidula munda
Strophodonta variabilis
Strophodonta canace
Orthis infera
Atrypa hystrix
Rhynchonella ambigua
Productus dissimilis
Lepidodendron and Sigillaria

Also several other undetermined species of Brachiopoda, and corals, and one or two species of crinoids.

Of the above list of species, only two, *Atrypa reticularis*, and *A. hystrix*, are known to occur in the Corniferous limestones below, while only three or four forms are at present known to extend upward into the middle Hamilton, (the shales, limestone, etc., lying above the blue shale and below the blue clay).

The two species *Atrypa reticularis* and *A. hystrix*, as they occur in the overlying rocks, assume a form so altered as to be as readily distinguished as if they were distinct species. The number of blue shale species which occur in the shales at Rockford, is greater than those of all the other divisions combined. A peculiar feature of this blue Shale Fauna, is the depauperation of most of its species.

As to the flora of this division, it is, as we have before stated, indigenous to it; none of the other serials containing any evidence of the former existence of either terrestial or marine plant life.

The rocks of the middle Hamilton carry a rich and varied fauna, more particularly in its lower and central portions.

Athyris vittata
Atrypa hystrix
Aulopora serpens
Aviculopecten pecteniformis
Calceocrinus clarus
Cladopora lichenoides
Cladopora fisherii
Platyceras rectum
Platyceras auriculatum
Crania bordeni
Cryptonella planirostra
Cyathophyllum davidsonii
Cystiphyllum americanum
Phacops bufo
Discina media
Stromatopora alternata
Gomphoceras lunatum
Megistocrinus latus
Meristella haskensii
Monticulipora monticula
Orthis iowensis
Orthis livia
Paracyclas ohioensis
Pentamerella dubia
Favosites hamiltonensis
Platyceras ammon
Platyceras argo
Platyceras bucculentum
Platyceras cymbium
Spirifera aspera
Spirifera ziczac
Spirifera raricosta
Spirifera subvaricosa
Spirifera subattenuata
Spirifera fimbriata
Spirifera mucronata (*rare*)
Spirifera formosa
Streptorhynchus chemungensis
Strophodonta demissa
Zaphrentis exigua

Atrypa reticularis
Aulopora conferta
Aviculopecten parilis
Chonetes pusilla
Chonophyllum ponderosum
Cladopora romerii
Platyceras symmetricum
Platyceras cymbium
Platyceras bucculentum
Crania hamiltonensis
Cryptonella rectirostra
Cyathophyllum scyphus
Heliophyllum halli
Discina doria
Discina seneca
Stromatopora incrustans
Leiorhynchus alta
Megistocrinus farnsworthi
Meristella meta
Euomphalus cyclostomus
Orthis vanuxemi
Paracyclas lirata
Pentamerus comis
Philipsastrea gigas
Favosites niaulus
Platyceras tetis
Platyceras conicum
Platyceras carinatum
Platyceras erectum
Spirifera raricosta
Spirifera tullia
Spirifera varicosa
Spirifera subumbonata
Spirifera pinnata
Spirifera parryana
Spirifera mannii
Spirifera euruteines
Terebratula romingeri
Stromatopora incrustans

In places these rocks contain a rich fish fauna, as well as numerous new and described species of shells, corals, etc., which are not at present known to occur in the rocks of any other area.

The mingling of the lower and upper (Chemung) Devonian faunas is here greater than in any of the other divisions of the rocks of this age in the State.

The grouping of Fossils of the middle Hamilton, differs considerably at different localities; although not to such an extent as has been heretofore generally supposed. The lithological character of the beds of the middle Hamilton, are usually very variable, so variable, indeed, as to make it a matter of great difficulty, and often an impossibility, to trace any particular bed for any considerable distance by this character.

Some portions of the strata of this horizon, as at Charles City and Independence, are traversed by more or less regular wave-like undulations.

The thickness of the Corniferous and Hamilton rocks vary somewhat in different portions of their area.

According to the record of the boring of the artesian well at Cedar Rapids,[1] the thickness of the Corniferous and Hamilton strata is, at that place, shown to be 380 feet.

Adding to this thirty feet, for the blue shales at Independence, and fifty feet (estimated thickness) for the Hamilton rocks (including the blue clay at Rockford etc.) lying above the highest beds of the Cedar Rapids section, we have an aggregate thickness, of the rocks of the Corniferous and Hamilton groups in Iowa, of 430 feet.

Succeeding the Hamilton, in the northwest portion of its area, is the highest division of the rocks of this age in the State.

This serial, which is plainly a sequent of the Hamilton, is known to attain a thickness of forty-five feet, and is made up, for the greater part, of a yellowish brown argillaceous, and sometimes slightly arenaceous, shaley limestone, which weathers to a stiff yellow, sometimes light buff, clay; and in places contains considerable numbers of ferruginous concretions. These shales are sharply defined, both serially, lithologically, and palaeontologically, and are a vast repository of beautifully preserved fossil remains; a large majority of which are peculiar to them.

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[1] We are under obligations to C. J. Fox, Esq., superintendent of the Cedar Rapids Water Co., for a record of this boring, together with samples of the rocks (2225 feet) passed through.

PLATE XVI.

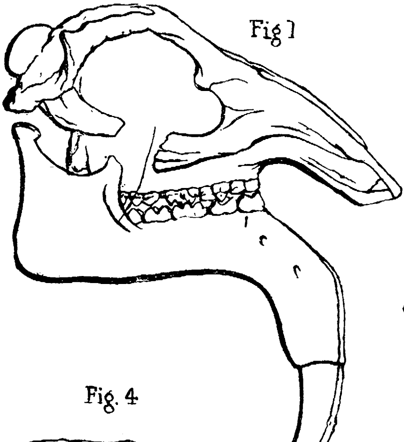


Fig 1

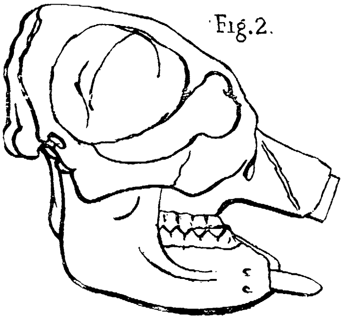


Fig.2.

Fig.13.

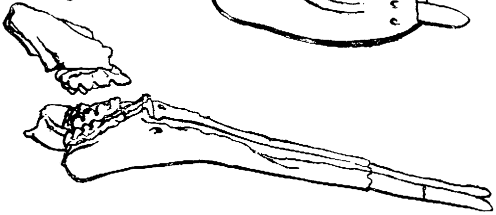


Fig.3.

Fig.16.

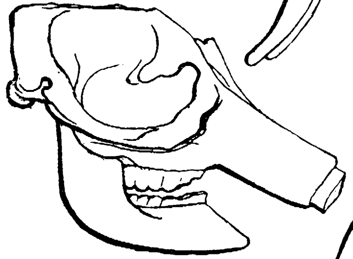
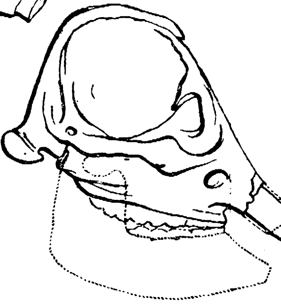


Fig. 4.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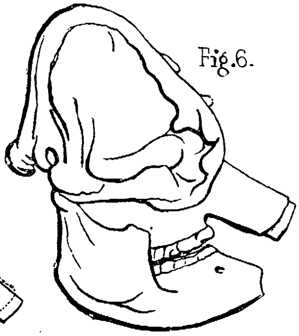
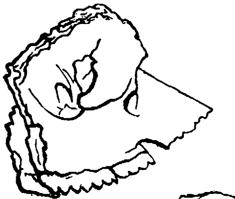


Fig.6.

Fig.18.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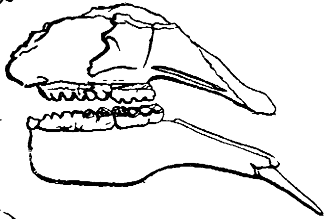


Fig. 8.

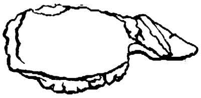


Fig 10

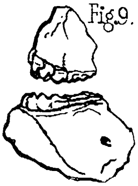


Fig.9.

Fig.20.

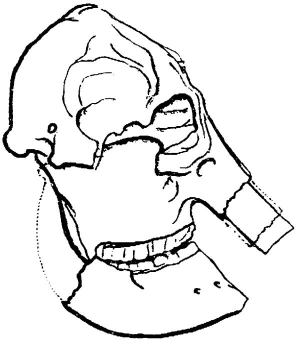


Fig. 11.

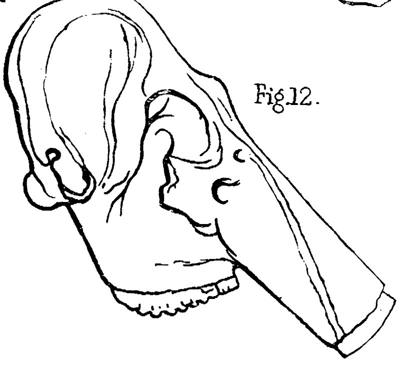


Fig.12.

Crania of Proboscidia.

PLATE XVI.

ig.2.

Fig.13.

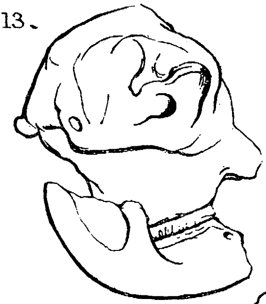


Fig.13a.

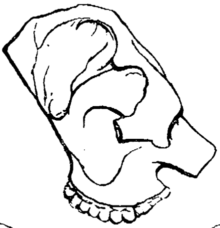


Fig.14.

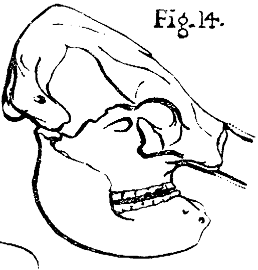
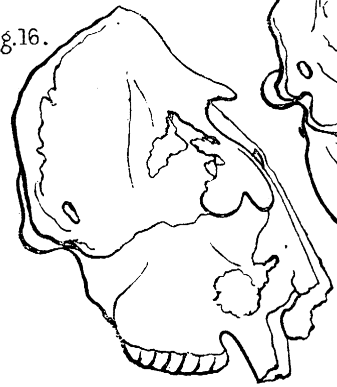


Fig.16.



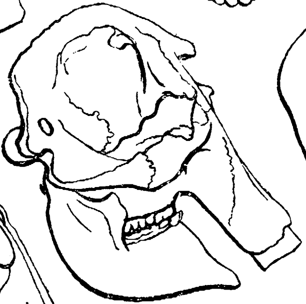


Fig.15

Fig.17.

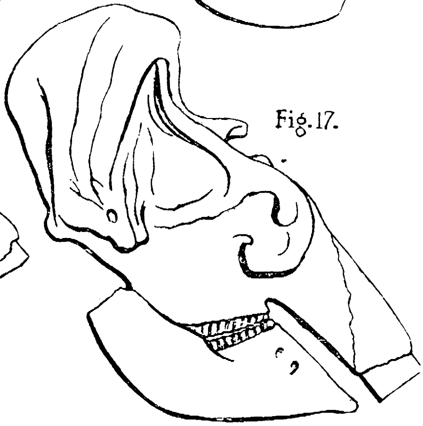
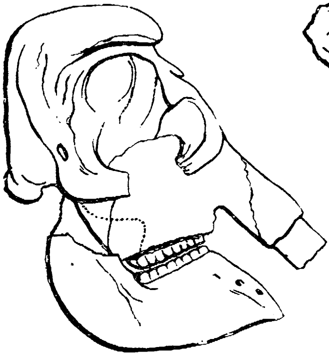


Fig.6.

Fig.18.



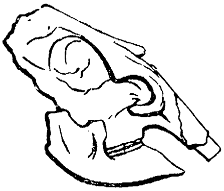


Fig 17a

Fig.19

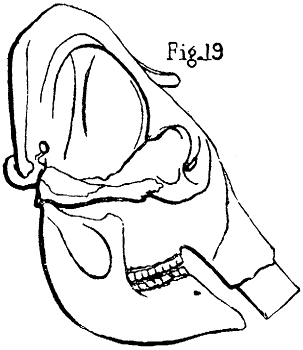


Fig.9.

Fig.20.

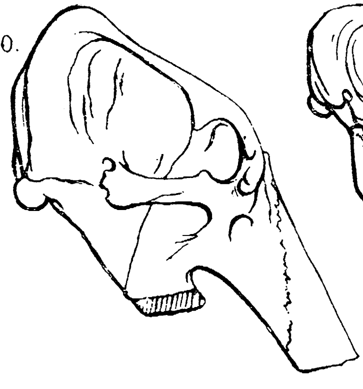


Fig.19b.

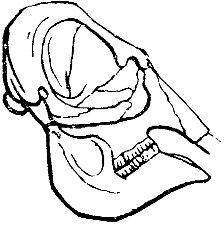
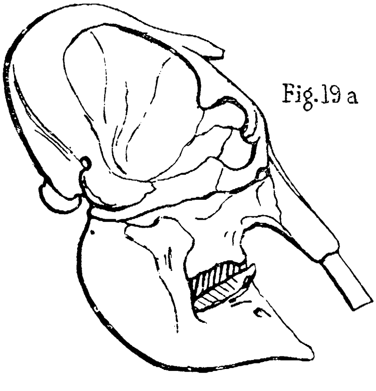


Fig.19a



Crania of Proboscidia.

This formation carries *two* faunas; one at the base, and another occupying the remainder of the division.

The fauna at the base is represented by considerable numbers of very minute, and finely preserved Brachiopoda, Gastropoda, Crustaceans, Foraminifers and Corals, a large number of which are as yet undescribed.

Not more than one or two of the forms, occurring at the base of the shales, are known to occur outside this formation.

Of the described species of this fauna, the following may be enumerated.

Athyris minutissima. C. L. Webster.
Platystoma mirum. Webster.
" pervetum. Webster.
Naticopsis rarus. Webster.
Turbo strigillata. Webster.
" incerta. Webster.
Holopea tenuicarinata. Webster.
Cyclonema brevilineatum. Webster.
" subcrenulatum. Webster.

For a more detailed description of this fauna etc., reference may be made to a paper on "Description of New Species of Fossils From the Rockford Shales of Iowa," which appeared in the November number of this Journal for 1888.

Of some of the described species which constitute the fauna of the higher horizon, and which are mostly typical of it, the following may be given.

Rhynchonella subacuminata. Webster
Paracyclas sabini. White.
" validalinea. Webster.
Atrypa reticularis.
" hystrix.
" " *var* planosulcata. Webster.
" " *var* elongata. Webster.
Spirifera whitneyi
" hungerfordii.
" strigosus. Meek, (*S. orestes*, H. and W).
" substrigosus. Webster.
" norwoodii. Meek, (*S. cyrtinaeformis*, H. and W).
" fimbriata.
" macbridei.

Smithia fohnanni.
“ multiradiata.
Stromatopora incrustans.
“ expansa.
“ solidula.
Caunopora planulata.
Fistulipora occidens.
Alveolites rockfordensis.
Aulopora iowensis.
“ saxivadum.
Zaphrentis solida.
Campophyllum nanum.
Chonophyllum ellipticum.
Cystiphyllum mundulum.
Spirorbis arkonensis.
“ omphalodes.
Acervularia inequalis.
Callonema lichas.
Stromatopora alternata.
Crania famelica.
Strophodonta arcuata.
“ reversa.
“ demissa.
“ canæ.
“ variabilis.
Productus dissimilis.
Streptorhynchus chemungensis..
Orthis iowensis.
Leiorhynchus iris.
Terebratula navicella.
Cryptonella salvini.
Naticopsis giganteum.
Loxonema pexatum.
“ crassum. Webster.
“ iowense. Webster.
“ giganteum. Webster.
Pachyphyllum woodmanii.
“ crassicostatum. Webster.
“ ordinatum. Webster.
Pachyphyllum crassum. Webster.

Platystoma lineatum.
Ambocoelia umbonata.
Productella truncata.

Aside from the foregoing enumeration, we have in our cabinet, large numbers of undescribed forms. Two-thirds or more, of the species which constitute the fauna of this horizon, are not known, at present, to occur outside of it.

When species, common to the shales, occur in any of the rocks below, and when fossils, peculiar to the lower groups, extend upward into the shales, they usually appear under a form, so altered that specimens from the different formations may be distinguished as readily as if they were distinct species.

About one-third of the species of the upper shale fauna occur in other divisions of the Devonian of this area, as well as most other areas of North America ; and very closely allied forms also occur in the European strata of this age (see description and figures of fossils in the geology of Russia and the Ural mountains etc.; also Walcott's Monograph, Palaeontology of the Eureka District, U. S. Geological Survey, 1884, and U. S. Geological Survey of Fortieth Parallel, Vol. IV ; as well as a paper by H. S. Williams, "On a remarkable Fauna at the base of the Chemung group of New York," American Journal of Science, February, 1883).

For a more detailed description of this formation, and its faunas, reference may be made to the following preliminary reports, which appear in various numbers of this Journal for 1888. "Notes on the Rockford Shales," and "Description of new species of Fossils from the Rockford Shales of Iowa," also "Contributions to the knowledge of the Genus Pachyphyllum," and "Description of new and imperfectly known species of Brachiopoda from the Devonian rocks of Iowa ;" as well as to a paper on "A description of the Rockford Shales of Iowa." which is accompanied by a map of the area occupied by the shales, that appears in Vol. V. of the Proceedings of the Davenport Academy of Science.

From the description of this formation here, and in previous preliminary reports, it will be seen in reality, to constitute a *new and distinct group of strata*, carrying *two* rich and varied faunas ; but which has not heretofore been recognized as such, and which is not developed in any other area in North America, or Europe ; although *all* contain links of evidence which demonstrate its Devonian age.

For this group of strata, heretofore provisionally designated by us as the "Rockford Shales," we would propose the name *Hackberry Group*, from Hackberry, in Cerro Gordo county, Iowa, where the most extensive and typical exposure of this formation isobserved.

In our forthcoming Monograph on the Devonian formation of Iowa, alluded to in a former paper ("Description of new species of Fossils from the Rockford Shales of Iowa," this Journal for November, 1888) a detailed description of the rocks of its several divisions, together with a list of all the Fossil species known to occur in them, will be given.

CONCLUSIONS.

It is thus shown, 1st, that the type section (Iowa) of the central continental area, differs materially from the type sections of other areas of North America.

2d. That there were nearly or quite as striking alterations of conditions during the successive deposition of strata in Iowa, as are indicated at the east, and that the rocks of this section are separable into well-marked natural divisions and subdivisions, not heretofore generally recognized as such.

3d. That the Devonian rocks of Iowa, instead of attaining a thickness of only one hundred and fifty feet to two hundred feet, as given by previous writers, are now known to attain an aggregate thickness of four hundred and seventy five-feet.

4th. That the Corniferous limestone is developed in Iowa to a thickness varying from one hundred and eighty feet to two hundred feet, and carries a fauna which is, to a great degree, peculiar to this stage.

5th. That the Corniferous limestone is succeeded upward by shales, limestones, clays, and sandstone of the Hamilton group.

6th. That the base of the Hamilton is marked, locally, by a thirty foot stratum of Blue Shales, carrying a peculiar fauna and flora which represents the "*Marcellus Shales*" of eastern areas, but which has not been heretofore so recognized.

7th. That what has been designated, by most writers on the subject, as Corniferous, Hamilton, and Chemung, limestone, sandstone, and Shales, does in reality represent the *Middle* Hamilton.

8th. That the upper portion of the Hamilton, in the northwest portion of its area, is represented by a stratum of blue clay from twenty to twenty-five feet in thickness, which, though devoid of Fossil remains, yet represents, in its order of sequence, the "*Gen-*

esee Shales" of eastern sections; and the present writer is the first to recognize it as such.

9th. That in the Iowa section is represented (so far as is at present known) the extreme western, attenuated, representatives of the eastern "*Marcellus Shales*" and "*Genesee Shales*."

10th, That the upper Hamilton (blue clay) is succeeded upward by a stratum of Argillaceous Shales, which everywhere occupy the highest position in the Devonian series in the State, and has an observed thickness of forty-five feet; although known to have attained a greater thickness prior to the glacial period, during which time they were more or less extensively eroded.

11th. That these Shales, which have been designated (provisionally) by the writer, in all his preliminary reports, as the "Rockford Shales," constitute, lithologically, stratigraphically, and biologically, a *new* and heretofore unrecognized (as such) group of strata, and which is not developed in any other area in North America, or Europe; although *all* contain links of evidence which demonstrate its Devonian age, and for which the writer has in this report proposed the name *Hackberry Group*.

EDITOR'S TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

The Philadelphia Academy of Natural Sciences has recently attacked the problem of original research in a practical manner. For many years the activity of the institution was restricted to the publication of work produced by scientific specialists on material contained in their own collections, and in the museums of other institutions. To this function it subsequently added that of giving instruction to classes in the natural sciences. We have often pointed out that the former line of activity is not enough for an institution which at one time was the only academy of original research in this country; and we have also expressed the opinion that the teaching of the natural sciences to classes of beginners, is not one of its proper uses. We have schools for teaching elsewhere, but